SMOKELESS AND COMBUSTIBLE TOBACCO USE AND MORTALITY: ANALYSIS FROM THE 1987 TO 2005 NATIONAL HEALTH INTERVIEW SURVEY

By

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ABSTRACT

Introduction: Few prospective studies have examined mortality outcomes associated with smokeless tobacco use in the US and information is limited regarding the risks associated with former and current exclusive smokeless tobacco users compared to combustible tobacco smoking and dual use.

Objective: To investigate associations of smoking and smokeless tobacco use with all-cause, cancer, cardiovascular disease, and chronic lower respiratory disease mortality in US adults.

Methods: We studied 127,995 adults, 18 years of age or older, who participated in the National Health Interview Survey 1987, 1992, 1998, 2000 and 2005 Cancer Control Supplement and were followed for mortality through December 2011. Information on history of combustible tobacco (cigarettes, pipes or cigars) smoking and smokeless tobacco (SLT: chewing tobacco or snuff) use was assessed at baseline. Cox proportional hazards models were used to estimate hazard ratios (HR) and 95% confidence intervals (CI) for mortality outcomes comparing former and current SLT users, former and current smokers and current dual users to never tobacco users.

Results: 51% of participants were never tobacco users, 1% former SLT users, 1% current SLT users, 22% former smokers, 25% current smokers and 1% current dual users. After a median follow-up time of 12 years, there were 23,405 deaths. After multivariable adjustment, the risk for all-cause mortality was higher for combustible tobacco users compared to never users (HR [95% CI] were 1.29 [1.25-1.34], 1.85 [1.78-1.93] and 1.69 [1.48-1.94] for former smokers, current smokers and current dual users respectively). The risk for death during follow-up time for exclusive SLT users was not significantly different from never users (HR [95% CI]: 0.93 [0.76-1.14] for former SLT users and 0.95 [0.80-1.12] for current SLT users).

Conclusions: Compared to never tobacco users, combustible tobacco users had higher risk in all-cause, cancer, cardiovascular disease, and chronic lower respiratory disease mortality. Exclusive smokeless tobacco users did not have higher risk than never tobacco users. These results suggest that using smokeless tobacco as a replacement for combustible tobacco smoking may reduce mortality for adults with a history of smoking.

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INTRODUCTION

Mortality due to cigarette smoking is estimated to rise to 7.2 million worldwide in 2017.[1] In the United States, the Centers for Disease Control and Prevention (CDC) estimated 480,000 deaths annually were related to cigarette smoking.[2] Cigarette smoking has been associated with several cancers including lung, head and neck, kidney, bladder, liver, pancreas, stomach, cervix, colon, and rectum and is also a major risk factor of cardiovascular diseases.[3] Even though the prevalence of cigarette smoking has greatly declined since the 1980s, data from CDC indicates that 15.1% of U.S. adults were cigarette smokers in 2015.[4] Reducing cigarette smoking among U.S. population has always been the major task for tobacco control and intervention.[3] As a British nicotine researcher Dr. Russell had suggested in his 1976 British Medical Journal article, "People smoke for nicotine but they die from the tar"[5] thus the use of combustible tobacco products which yield tar, should be minimized. Smokeless tobacco (SLT) products such as chewing tobacco on the other hand does not produce combustion gases and particles,[6] however, smokeless tobacco still contains carcinogenic tobacco-specific nitrosamines.[6,7] Few studies have examined smokeless tobacco products with mortality outcomes in the United States[8-11] with two studies finding no association between SLT use and all-cause mortality or death from cancer and cardiovascular[8-9] and two studies showing that SLT use may be associated with higher mortality due to cardiovascular diseases but no difference for cancer mortality.[10,11] A study using data from the First National Health and Nutrition Examination Survey Epidemiologic Followup Study found no difference in all-cause, cancer, or cardiovascular disease mortality for SLT users compared to non-tobacco users, except for some evidence of an increase in cancer mortality among female smokeless tobacco users.[9] However, this study was limited by examining ever use of smokeless tobacco (combined current and former user) and was not able to account for use of

other combustible non-cigarette tobacco products (e.g., cigars and pipes). A prospective study using data from the Cancer Prevention Study (CPS) I, which enrolled participants in 1959 (followed for 12 years), and CPS II, which enrolled participants in 1982 (followed for 18 years), showed significant higher all-cause and cardiovascular disease mortality for men who reported exclusive current smokeless tobacco use compared to never tobacco users.[10] Though, this study excluded men who reported current or former smoking of cigarettes, cigars, or pipes and no information was available on the use of chewing tobacco or snuff by women. Therefore, the objective of our study was to investigate associations of former and current SLT and combustible tobacco use compared to never tobacco use with all-cause, cancer, cardiovascular and respiratory mortality in a representative sample of US adults in the National Health Interview Survey (NHIS). The availability of information on current and past use of both SLT and cigarette and non-cigarette combustible products in NHIS allowed us to examine the health risk from use of combustible and smokeless tobacco separately and in combination.

METHODS

Study Population

The National Health Interview Survey (NHIS) is a nationwide in-person annual survey of approximately 35,000 households in the civilian non-institutionalized U.S. population conducted by the U.S. National Center for Health Statistics (NCHS; Centers for Disease Control and Prevention [CDC], Atlanta, GA) since 1957.[12] Since 1987, the National Cancer Institute periodically sponsors a Cancer Control Supplement (CCS) to the NHIS to focus on issues related to cancer-related health behaviors, screening, and risk assessment.[13] In the years of 1987, 1992,

1998, 2000 and 2005, one adult aged 18 or older per household was randomly selected for CCS interview with informed consent. In NHIS 1987 and 1992, African Americans were over sampled and in NHIS 1998, 2000, and 2005, African American and Hispanic subpopulations were over sampled to allow for more precise estimates in these groups. We aggregated the CCS data sets that linked to the National Death Index[14] to form the study population of 147,023 adults eligible for mortality follow-up and whose mortality status were ascertained. We excluded 5,735 adults whose tobacco use information was missing, 6,077 dual combustible and smokeless tobacco users who had quit SLT use or smoking by baseline, and 7,216 adults missing covariates of interest. The final sample size for this analysis was 127,995 adults.

Mortality Follow-up

Participants were followed for mortality from the date of survey participation (1987, 1991-1992, 1998, 2000 or 2005) through December 31, 2011. Vital status and cause of death were ascertained through probabilistic record matching between NHIS records and death certificates from the National Death Index.[14] The cause of death was determined using the underlying cause listed on death certificates, and coded using the International Classification of Diseases, 10th Revision (ICD-10). The primary outcome was all-cause mortality. Secondary outcomes were death from cancer (ICD-10 codes: C00-C97), cardiovascular diseases (CVD, ICD-10 codes: I00-I09, I11, I13, I20-I51, I60-I69) and chronic lower respiratory disease (CLRD, ICD-10 codes: J40-J47). Follow-up time for each participant was calculated as the difference between the age at the time of the NHIS interview and the age at the date of death, age 100 years or end of the mortality follow-up period (December 31, 2011), whichever occurred first. Follow-up was censored at age 100 years because the age was top-coded at 99 years and the probabilistic nature of the mortality ascertainment, the lower likelihood of being alive at 100 years or older.

Tobacco Use

Information on participant tobacco use was obtained from a self-reported questionnaire and defined based on history of use of combustible and tobacco products. Smokers were defined by history of use of combustible tobacco products including cigarettes, pipes and cigars. Those who ever smoked at least 100 cigarettes, 50 cigars, 50 times of pipes were considered ever smokers; those who answer "no" were classified as never smokers. Ever smokers who responded to the question: "Do you now smoke cigarettes/a cigar/a pipe everyday, some days, or not at all?" with "everyday" or "some days" were classified as current smokers; ever smokers who responded "not at all" were classified as former smokers. For participants who reported a history of cigarette smoking, information was obtained on the number of cigarettes smoked each day for "everyday" current smokers and average cigarettes smoked per day in the past 30 days for "some days" current smokers. SLT use was defined by history of use of chewing tobacco or snuff. Those who ever used chewing tobacco or snuff at least 20 times were considered ever SLT users; those who answer "no" were classified as never SLT users. Ever SLT users who responded to the question: "Do you now use chewing tobacco/snuff everyday, some days, or not at all?" with "everyday" or "some days" were classified as current SLT users; SLT users who responded "not at all" were classified as former SLT users. For year 1987, the current "everyday" and "some days" smokers or SLT users were not distinguished. The questions for 1987 NHIS were "Do you smoke/use cigarettes/a pipe/a cigar/chewing tobacco/snuff now?" Participants who were both never smokers and never SLT users were classified as never tobacco users ("Never Users"). For this analysis, tobacco use was categorized as former SLT use only ("Former SLT Users") who were former SLT users and never smokers, current SLT use only ("Current SLT Users") who were current SLT users and never smokers, former smokers only ("Former Smokers") who were

former smokers and never SLT users, current smokers only ("Current Smokers") who were current smokers and never SLT users, and current dual users ("Current Dual Users") who were current smokers and used SLT currently.

Other Covariates

Information on age, sex, body mass index (BMI), education level, family income, race/ethnicity and marital status were collected by questionnaire at the time of the interview (baseline). BMI was calculated by self-reported height and weight without shoes and treated as continuous variable. Education level was defined in four categories: less than high school, high school, some college, and college degree or beyond. Poverty-to-income ratio (PIR; the ratio of the family's income to its appropriate poverty threshold as defined by the US Census Bureau) was dichotomized as PIR <1.00 vs. ≥ 1.00. Race/ethnicity was defined as Hispanic, Non-Hispanic white, Non-Hispanic black and non-Hispanic other. Marital status was categorized as married with or without spouse living together or living together with partner vs. all others. Year of NHIS interview (1987, 1992, 1998, 2002 and 2005) was also included in the model and treated as a categorical variable to account for secular trends.

Statistical Analysis

We estimated multivariable adjusted hazard ratios (HR) and 95% confidence intervals (CI) for primary and secondary mortality outcomes comparing Former SLT Users, Current SLT Users, Former Smokers, Current Smokers and Dual Users to Never Users using Cox proportional hazards models with age as the time scale and individual starting follow-up times (age at interview) treated as staggered entries. Models were adjusted for sex, race/ethnicity, education, marital status, PIR, BMI and year of survey. Type 1 error rate was set at 0.05 level. All statistical analyses were performed using the "svy" package in STATA 14.2 (StataCorp. 2015.

Stata Statistical Software: Release 14. College Station, TX: StataCorp LP) to account for the sampling design and weights in NHIS and to obtain appropriate estimates and standard errors.[14-16]

RESULTS

Participant Characteristics

Table 1 shows the characteristics of study participants at baseline. Of the 127,995 adults included in this analysis, a little more than half of them (weighted prevalence: 51%) were Never Users (Table 1). Former Smokers and Current Smokers made up nearly the other half (25% and 21% respectively). Those who exclusively used smokeless tobacco (Former SLT and Current SLT) and Current Dual Users were each about one percent of the study population. Compared to Never Users, smokeless tobacco users including Former SLT, Current SLT Current Dual Users were younger. Among exclusive smokers, Current Smokers were somewhat younger (42.4 years vs. 44.4 years) and Former Smokers were about 10 years older than Never Users (Table 1). Those who ever used smokeless tobacco (Former SLT users, Current SLT users, and Current Dual Users) were mostly male (more than 85%) while Former Smokers and Current Smokers had approximately equal percentages of males and females and Never Users were about two thirds female (65%). Participants with a history of tobacco use (Former SLT Users, Current SLT Users, Former Smokers, Current Smokers and Current Dual Users) were more likely to be non-Hispanic white than Never Users (Table 1). Former SLT Users were more like to have some college education or beyond, while Current SLT Users, Current Smokers and Current Dual Users were more likely to have less than high school education. Marital status was similar across tobacco use categories except for a higher percentage of Former Smokers that reported being married or

living with a partner. Current tobacco users (Current SLT Users, Current Smokers and Current Dual Users) had higher percentages with household incomes below the poverty threshold while Former Smokers had the fewest. BMI was higher for Current SLT Users compared to all other groups (Table 1). For participants that reported current cigarettes smoking, cigarettes smoked per day was similar (mean cigarettes/day were 16.6 cigarettes for Current Smokers and 17.4 cigarettes for Current Dual Users, Table 1).

Tobacco Use and Mortality Outcomes

All-cause mortality. The median follow-up time was 12 years for the study population, 7.6 years for participants who were assumed deceased and 13.3 years for participants who were assumed alive at the end of follow-up. A total of 23,405 participants died during follow-up. After adjustment for age, sex, race/ethnicity, education, marital status, poverty level, BMI and year of survey, the risk for all-cause mortality was higher for combustible tobacco users compared to never users (HR [95% CI] were 1.29 [1.25-1.34], 1.85 [1.78-1.93] and 1.69 [1.48-1.94] for Former Smokers, Current Smokers and Current Dual Users respectively, Table 2). The risk for death during follow-up time for exclusive smokeless tobacco users was not significantly different from Never Users (HR [95% CI]: 0.93 [0.76-1.14] for Former SLT Users and 0.95 [0.80-1.12] for Current SLT Users, Table 2).

Cancer mortality. There were 5,524 deaths due to any cancer. The multivariable adjusted risk for cancer mortality was higher for combustible tobacco users compared to never users (HR [95% CI] were 1.53 [1.42-1.64], 2.73 [2.52-2.95], 2.03 [1.52-2.71] for Former Smokers, Current Smokers and Current Dual Users respectively, Table 2). The risk of dying from cancer during follow-up time for exclusive smokeless tobacco users was not significantly different from Never

Users (HR [95% CI] were 0.71 [0.41-1.22], and 1.15 [0.80-1.63] for Former SLT Users and Current SLT Users respectively, Table 2).

Cardiovascular disease mortality. There were 6,707 deaths due to CVD. The multivariable adjusted risk for CVD mortality was significantly higher for former and current smokers and significantly lower for current SLT users compared to never users (HR [95% CI] were 1.10 [1.03-1.17] for Former Smokers, 1.56 [1.45-1.68] for Current Smokers and 0.70 [0.53-0.93] for Current SLT Users, Table 2). There was no difference in the risk of dying from CVD for former smokeless tobacco users or current dual users (HR [95% CI] were 0.84 [0.60-1.16] for Former SLT Users and 1.27 [0.94-1.72] for Current Dual Users, Table 2).

Chronic lower respiratory disease mortality. There were 1,297 deaths due to chronic lower respiratory disease. The multivariable adjusted risk for CLRD mortality was higher for combustible tobacco users compared to never users (HR [95% CI] were 5.25 [4.28-6.45], 10.08 [8.17-12.43], 12.12 [7.57-19.41] for Former Smokers, Current Smokers and Current Dual Users respectively, Table 2). The risk of dying from CLRD during follow-up time for exclusive smokeless tobacco users was not significantly different from Never Users (HR [95% CI] were 0.53 [0.07-3.85], and 1.04 [0.33-3.29] for Former SLT Users and Current SLT Users respectively, Table 2).

DISCUSSION

This study using nationally representative data of the US population, investigated the association between smokeless tobacco use and various mortality outcomes. Compared to participants who never used tobacco products, exclusive combustible tobacco smokers had statistically higher mortality risk while exclusive smokeless tobacco users did not show different mortality than never users. These findings were consistent among primary outcome (all-cause

mortality) and three different secondary endpoints (death from cancer, cardiovascular disease and chronicle lower respiratory disease). In addition to that, within the same category of tobacco products, either combustible or smokeless, participants who quit using tobacco experienced lower mortality risk compared to current users in all mortality outcomes.

Mortality Outcomes among Exclusive Combustible Smokers vs. Exclusive SLT Users

This study using US national representative data compared mortality between exclusive combustible smokers and exclusive smokeless tobacco users. Previous US studies have examined the mortality between exclusive SLT users with never users,[9-11] or between SLT users vs non-users among former smokers.[17] A systematic review of Swedish snus use among men found that SLT use was significantly associated with lower all-cause mortality than cigarette smokers.[27] Among the exclusive smokers and exclusive smokeless tobacco users in this study, risks for all-cause, cancer, CVD and CLRD mortality were highest for the Current Smokers, followed by Former Smokers, then Current SLT Users and lowest for Former SLT Users, except for CVD mortality where Current SLT Users had lower risk than Former SLT Users, although these findings were not statistically significant ($p=0.33$, data not shown). The benefits of cigarette smoking cessation with reduced risk in all-cause mortality, death due to cancer and cardiovascular disease is well studied and widely accepted.[3] In addition to lower risk for former cigarette smokers compared to current smokers, this study showed that quitting smokeless tobacco could also bring health benefits. Indeed, risk for mortality endpoints were lower for former SLT users than current SLT Users, except for a lower risk for CVD mortality for current SLT users.

Mortality Outcomes among Exclusive SLT Users vs. Never Users

This study found that exclusive smokeless tobacco users had similar or lower mortality for all endpoints compared to never tobacco users. For all-cause mortality, a previous study using data from Tobacco Use Supplement of Current Population Survey (TUS-CPS) from year 1985 to 2011 showed a similar result.[11] Using data from the First National Health and Nutrition Examination Survey Epidemiologic Followup Study (adults aged ≥45 years at baseline [1971–1975] followed for 20 years), there was similarly no difference in all-cause, cancer, or cardiovascular disease mortality for SLT users compared to non-tobacco users (defined as non-users of SLT or cigarettes), except for some evidence of an increase in cancer mortality among female smokeless tobacco users.[9] Another US study which used data from CPS I in 1959 (followed for 12 years) and CPS II in 1982 (followed for 18 years) found that men who reported current use of snuff or chewing tobacco had higher all-cause, coronary heart disease and stroke mortality compared to men that were non users in both CPS I and II; however current use of chewing tobacco or snuff at baseline was associated with higher risk for lung cancer and total cancer mortality only in CPS II and with higher risk for death from respiratory diseases only in CPS I and former use of snuff or chewing tobacco was not associated with any endpoint in CPS II (data on former use not available in CPS I).[10] The study in CPS I and CPS II was restricted to men and additionally participants were older (mean age around 60 years at enrollment) than the age distribution of participants in this study (around 45 years at interview) and the study with TUS-CPS data (median within 35-49 years at baseline). Also, contrary to our data, current exclusive SLT users for CPS I and both current and former exclusive SLT users for CPS II were older than the never users.

For cancer mortality, we found a non-significant modest increase in cancer mortality for current SLT users and no difference for former SLT users compared to never tobacco users. In the TUS-

CPS study, cancer mortality for both exclusive current and former SLT was similar to never tobacco users (HR [95% CI] was 1.01 [0.73, 1.39] for former SLT users and 0.99 [0.82, 1.21] for current SLT users compared to never tobacco users).[11] Several US and international studies have found that SLT users had higher risk in head and neck cancer (HNC) including oral cancer compared to never tobacco users,[18-20,] however only two studies[9,18] examined mortality and they included few exclusive SLT users with cancer mortality not significantly associated with SLT use from these studies. Beside the relatively few exclusive SLT users, oral cancer which is associated with SLT use, is rare (3% of all cancer incidence) in the US[21] and the five-year survival rate for oral cancer is 64.8%.[21] This may lead to fewer observed events for a common cancer mortality outcome for exclusive SLT users and insufficient statistical power to detect the difference in total cancer mortality.

For cardiovascular disease mortality, the current SLT users had significant lower mortality compared to never tobacco users while former SLT users had a similar mortality as never users. Our findings differ from previous studies which have found higher CVD mortality associated with SLT use compared to non-tobacco users.[10,22,23] Our results were also consistent in analyses comparing risk for coronary heart disease and stroke mortality as separate endpoints (data not shown). In the study using data from Tobacco Use Supplement of Current Population Survey, there was significantly higher mortality from coronary heart disease but no difference in mortality from cerebrovascular disease for current exclusive SLT users compared to never tobacco users.[11]

In this study, CLRD mortality did not differ for exclusive SLT users compared to never tobacco users which differs partially from findings from CPS I and CPS II which found higher respiratory mortality for men who were current exclusive smokeless tobacco in CPS I (1959–

1972) but no difference in CPS II (1982–2000).[10] In our study there were very few deaths from CLRD for SLT users (1 for Former SLT Users and 3 for Current SLT which may have limited our ability to examine risk for death from CLRD in our study compared to CPS.)

Mortality Outcomes among Current Dual Users of Combustible and Smokeless Tobacco Products

In this study, current dual users of combustible and smokeless tobacco products had higher risk for all-cause, cancer, CVD and CLRD mortality compared to never users; although findings were not statistically significant for CVD mortality. Furthermore, Current Dual Users had higher mortality than Current SLT Users but lower mortality than Current Smokers for all endpoints except for CLRD mortality for which Current Dual Users had higher mortality risk. Compared to Current Smokers, a larger proportion of Current Dual Users smoked cigars or pipes (17% vs. 5%) in this study. A study in the Multi-Ethnic Study of Atherosclerosis found that cigar and pipe smoking was associated with decreased lung function and higher odds of airflow obstruction.[26] Additionally, although the average cigarettes smoked per day was similar between Current Dual Users and Current Smokers in this study, Current Dual Users were less likely to smoke cigarettes everyday than Current Smokers (65% vs. 78%). This finding suggests that some cigarette smokers may have reduced their frequency of smoking cigarettes by using smokeless tobacco products and subsequently lower their mortality risk compared to those who only smoke cigarettes and/or other combustible tobacco products. Indeed, in a study using data from 8,562 adults who participated in NHIS 2010 showed higher odds of successful cigarette smoking cessation among SLT users (n=894) than those smokers who did not use SLT (n=7668).[25]

Strengths and Limitations

The major strength of this study is the use of national representative survey information for US adults. The combined dataset from years 1987, 1992, 1998, 2000, and 2005 surveys yielded a large sample size which gave sufficient power to detect differences for several major causes of mortality between former and current exclusive smokeless tobacco users and former and current combustible smokers as well as dual users of these products. The availability of information on smokeless as well as cigarette and non-cigarette combustible tobacco products allowed us to compare risk for mortality to never users of these products. Information was available on both former and current use of these products which allowed use to evaluate the impact of quitting of these products on mortality outcomes. Follow-up for mortality endpoints were relatively long with a median follow-up time of more than 10 years. This study has some limitations, however. As the surveys had spanned across almost 20 years, the tobacco products used may have changed. In NHIS 2000 and 2005 information on bidis smoking was also included in the questionnaire. In a sensitivity analysis, including bidi smoking as a combustible tobacco product in defining tobacco use status, results were similar. Additionally, we included the survey year as a covariate in the model to account for potential secular trends. Another limitation is the cross-sectional nature of the NHIS survey data. Tobacco use could change over time and the classification of tobacco use behavior at baseline may not reflect the etiologically relevant exposure period. In this study, dual combustible and smokeless tobacco users who had quit SLT use or smoking by baseline were excluded as information on timing of quitting for SLT (needed to assess the order of quitting) was unavailable, therefore we were unable to examine mortality risk for these individuals. A study using CPS II data showed higher cancer mortality for SLT users who were former cigarette smokers compared to former cigarette smokers who quit using tobacco entirely.[17] Lastly, this study examined risk for mortality outcomes and there was no

ascertainment for incidence of tobacco related diseases like cancer, CVD and respiratory outcomes. Diseases associated with smokeless tobacco use like oral cancer[18-20] may not be the eventual cause of death but could greatly impact the quality of life for these tobacco users. Additional research evaluating the potential risk for these morbidity outcomes will lead to better understanding of public health implications of smokeless tobacco use.

Conclusion

Compared to combustible tobacco smoking, smokeless tobacco use was associated with lower risk of all-cause, cancer, CVD and chronical lower respiratory mortality. These results suggest that using smokeless tobacco as a replacement for combustible tobacco smoking may reduce mortality for adults with a history of smoking. Further prospective studies about smokeless tobacco risk compared to never tobacco users are needed. Before there is a definitive conclusion about the potential hazard with smokeless tobacco, no smokeless tobacco initiation should be promoted among never tobacco users and policies with smokeless tobacco control should be enforced.

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Table 1. Participant characteristics by tobacco use

	Overall	Never Users	Former SLT Users	Current SLT Users	Former Smokers	Current Smokers	Current Dual Users
N	127,995	65,447	888	1,100	27,351	32,150	1,059
Age (year)	45.9 (0.1)	44.4 (0.1)	36.7 (0.5)	39.3 (0.6)	54.2 (0.1)	42.4 (0.1)	37.2 (0.5)
Sex							
Female	75,095 (57.4%)	43,649 (64.9%)	115 (10.7%)	221 (14.9%)	13,711 (50.3%)	17,352 (53.0%)	47 (3.5%)
Race/Ethnicity							
Non-Hispanic White	89,485 (75.5%)	42,248 (70.7%)	727 (85.8%)	865 (84.6%)	21,540 (83.4%)	23,188 (77.4%)	917 (89.1%)
Non-Hispanic Black	17,304 (11.5%)	9,599 (13.0%)	83 (7.2%)	177 (10.6%)	2,562 (7.6%)	4,799 (12.3%)	84 (5.4%)
Hispanic	17,121 (9.1%)	10,946 (11.4%)	60 (4.9%)	32 (2.0%)	2,654 (6.5%)	3,391 (7.4%)	38 (2.7%)
Other	4,085 (3.9%)	2,654 (5.0%)	18 (2.0%)	26 (2.7%)	595 (2.5%)	772 (2.9%)	20 (2.9%)
Education							
<High School	26,499 (17.9%)	12,587 (16.0%)	139 (12.7%)	338 (25.7%)	5,325 (17.3%)	7,808 (22.0%)	302 (26.6%)
High school	41,024 (31.3%)	19,187 (28.3%)	240 (25.0%)	345 (31.6%)	8,634 (31.1%)	12,216 (37.8%)	402 (38.0%)
Some College	32,471 (26.8%)	16,766 (27.0%)	262 (30.5%)	260 (26.8%)	6,925 (26.5%)	8,020 (26.6%)	238 (24.2%)
≥ College Degree	28,001 (23.9%)	16,907 (28.7%)	247 (31.8%)	157 (16.0%)	6,467 (25.0%)	4,106 (13.6%)	117 (11.2%)
Marital Status							
Married[a]	68,769 (53.7%)	34,596 (52.9%)	464 (53.9%)	549 (51.8%)	16,620 (60.5%)	15,944 (49.4%)	596 (53.3%)
Poverty Level							
PIR<1	19,006 (13.4%)	9,979 (13.6%)	124 (12.2%)	239 (19.1%)	2,607 (8.6%)	5,894 (17.0%)	163 (16.0%)
BMI (kg/m^2)	27.0 (0.1)	26.9 (0.1)	26.9 (0.2)	28.0 (0.7)	27.8 (0.2)	26.5 (0.2)	26.5 (0.2)
Cigarettes/day[b]	—	—	—	—	—	16.6 (0.1)	17.4 (0.5)
NHIS Survey Year							
1987	36,543 (20.5%)	17,130 (18.8%)	257 (19.4%)	357 (21.4%)	7,612 (19.7%)	10,783 (24.5%)	404 (25.3%)
1992	10,009 (5.9%)	4,878 (5.6%)	79 (7.0%)	101 (6.5%)	2,205 (6.0%)	2,666 (6.4%)	80 (5.6%)
1998	27,937 (24.2%)	14,386 (24.0%)	262 (33.4%)	230 (25.0%)	6,128 (24.6%)	6,705 (23.8%)	226 (25.9%)
2000	27,721 (24.2%)	14,761 (24.5%)	132 (18.1%)	229 (24.8%)	5,910 (24.5%)	6,527 (23.4%)	162 (20.1%)
2005	25,785 (25.2%)	14,321 (27.1%)	159 (22.1%)	183 (22.2%)	5,473 (25.1%)	5,463 (21.9%)	186 (23.1%)

Abbreviations: PIR, Poverty-Income Ratio; BMI, body mass index; Values represent mean(SD) for continuous variables and N (weighted %) for categorical variables.

a. Married: married with or without spouse living together or lived together with partner

b. Cigarettes/day information was only available for current cigarette smokers (N= 30,609 for Current Smokers and N=911 for Current Dual Users with available information on cigarettes per day).

Table 2. Hazard ratio (95% CI) for mortality outcomes by tobacco use

	N	All-cause mortality		Cancer mortality		CVD mortality		CLRD mortality	
		# of deaths	HR (95% CI)	# of deaths	HR (95% CI)	# of deaths	HR (95% CI)	# of deaths	HR (95% CI)
Never Users	65,447	9,316	1.00 (ref)	1,785	1.00 (ref)	2,962	1.00 (ref)	174	1.00 (ref)
Former SLT Users	888	100	0.93 (0.76-1.14)	17	0.71 (0.41-1.22)	34	0.84 (0.60-1.16)	1	0.53 (0.07-3.85)
Current SLT Users	1,100	202	0.95 (0.80-1.12)	44	1.15 (0.80-1.63)	56	0.70 (0.53-0.93)	3	1.04 (0.33-3.29)
Former Smokers	27,351	7,094	1.29 (1.25-1.34)	1,662	1.53 (1.42-1.64)	2,003	1.10 (1.03-1.17)	513	5.25 (4.28-6.45)
Current Smokers	32,150	6,478	1.85 (1.78-1.93)	1,965	2.73 (2.52-2.95)	1,600	1.56 (1.45-1.68)	585	10.08 (8.17-12.43)
Current Dual Users	1,059	215	1.69 (1.48-1.94)	51	2.03 (1.52-2.71)	52	1.27 (0.94-1.72)	21	12.12 (7.57-19.41)

Abbreviations: CI, confidence interval; CVD, cardiovascular disease; CLRD, chronic lower respiratory disease; HR, hazard ratio
All models adjusted for age, sex, race/ethnicity, education, marital status, PIR, BMI and survey year.

Biography

Tingju Hsu was born in 1966 in Taiwan. She finished her undergraduate degree from National Taiwan University. She went to University of Michigan to obtain her Master of Science in Biostatistics in 1993. She was the teaching assistant for Probability and Distribution Theory, and Biostatistics Inferences. She worked as a Research Associate at Survey Research Center, Institute for Social Research, University of Michigan from 1994-1996. Tingju started her Master of Science program at the department of Epidemiology, Johns Hopkins School of Public Health in 2016. She was the teaching assistant for Epidemiologic Method, Cancer Epidemiology, and Stata Programming.